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13. ABSTRACT (Maximum 200 words) THE OBJECTIVES OF THE HAZARD ABATEMENT PLAN IS TO ELIMINATE THE PRESENCE OF NDMA WITHIN THE HYDRAZINE STORAGE AND BLENDING FACILITY AND SECONDLY TO ELIMINATE THE POTENTIAL EXPOSURE OF WORKERS TO HYDRAZINE AND UDMH DURING ANY HYDRAZINE OPERATION. TO ACCOMPLISH THIS OBJECTIVE A PHASE APPROACH WILL BE EMPLOYED TO MINIMIZE EMISSIONS. THE PLAN CONSISTS OF THE FOLLOWING FOUR PHASES: (1) FACILITY CLEAN-UP AND DECONTAMINATION, (2) FACILITY MODIFICATION-NDMA SOURCES, (3) FUEL SYSTEMS MODIFICATIONS, (4) DRUM FILLING AND CLEANING AND MISCELLANEOUS. <div style="text-align: right;">DTIC QUALITY INSPECTED 5</div>					
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ROCKY MOUNTAIN ARSENAL
HYDRAZINE BLENDING & STORAGE FACILITY

HAZARD ABATEMENT PLAN

1. PRESENT SITUATION:

a. Rocky Mountain Arsenal (RMA) operates the Hydrazine Storage and Blending Facility for the United States Air Force (USAF). Hydrazine operations consist of downloading/uploading of railroad cars and tanker trucks, storage and blending of rocket fuels. Bulk storage/blending involves hydrazine and Unsymmetrical Dimethylhydrazine (UDMH) and Aerozine 50 (Product Mix). This facility also fills drums from the bulk storage and stores other fuels such as Monomethyl Hydrazine (MMH), Monopropellant Hydrazine (MPH) and Hydrazine 70 (Hydrazine/Water mixture). The USAF utilizes the RMA facility as a depot to receive, store, blend and issue hydrazine fuels to various customers. RMA has operated the hydrazine facility under an Interservice Support Agreement (ISSA) since 1960.

b. During Jan, Feb, and Mar 1982, the Department of Labor (DOL)/Occupational Safety & Health Administration (OSHA) District Office conducted an inspection of the hydrazine facility. This inspection included sampling of the work area both during operational and non-operational periods for Hydrazine, UDMH, and N-Nitrosodimethylamine (NDMA). Background samples of other areas on the Arsenal were also taken. The OSHA sampling results are attached as Appendix A. Verbal guidance from OSHA indicating that safety upgrades were recommended for continued operation of the facility resulted in RMA stopping routine hydrazine operations. The USAF was formally advised of this situation on 5 May 1982. A meeting was held at RMA with the regional/district office of OSHA on 19 May 1982 at which time OSHA presented its findings and recommendations and participated with the USAF/USA representatives in discussion of possible corrective actions. OSHA inspection findings are attached as Appendix B. The USAF/USA indicated to OSHA that they shared OSHA concern for worker protection and that a plan of corrective actions would be prepared and submitted to OSHA.

2. HAZARD ASSESSMENT:

a. Review and analysis of the OSHA sampling report indicates the following:

1) During hydrazine transfer operations, the primary operation of the facility, personnel were not exposed to hydrazine or UDMH above the permissible personnel exposure limits. However during one specific activity, the operation of taking the physical inventory of the storage tanks, personnel were exposed to UDMH above the permissible personnel exposure limit. Prior to the OSHA inspection, RMA had recognized the necessity to incorporate engineering controls to eliminate the exposure and physical hazard of this operation. Specialized equipment had been purchased and is currently on hand awaiting installation. The following abatement plan does include the installation of the tank liquid level indicators as has been previously planned, which will eliminate this hazard.

2) During all operations sampled, personnel were exposed to NDMA (above the detectable limit). NDMA, also was detected at various locations within the facility, when sampled nine days after operations had been terminated. The source of NDMA could be due to the presence of UDMH (at non-detectable levels) or, as is more likely the situation, due to the presence of a sizeable open sump within the facility with waste water containing NDMA. NDMA is a regulated suspect carcinogen. OSHA representative's at the 19 May 1982 meeting, indicated that it was the opinion of the national OSHA office that the OSHA regulation for NDMA (29 Code of Federal Regulations (CFR) 1910.1016) applied to the situation at RMA. Based on this determination, OSHA officials presented 21 items of non-compliance (See Appendix B). RMA position has been that hydrazine blending and storage operations do not fall within the scope of this regulation, based upon the statement within the regulation that the regulation shall not apply to solid or liquid mixtures containing less than 1.0 percent by weight or volume of NDMA. Furthermore, as stated in the regulation, the regulation applies to any area in which NDMA is manufactured, processed, repackaged, released, handled or stored, which is not the situation at RMA, where the NDMA is formed in the atmosphere from oxidation of UDMH. Regardless of the legality of the regulation, RMA's position is to comply with the specific requirements insofar as it possible given the peculiar nature of an outdoor facility handling the spontaneously flammable hydrazine fuels. RMA recognizes that a serious situation does exist and the subject OSHA regulation on NDMA presents a viable guideline for the elimination of this hazard. Further discussion on the issue concerning the applicability of 29 CFR 1910.1016 is not at this time in the best interest of the concerned parties.

3. HAZARD ABATEMENT PLAN:

a. The objective of the hazard abatement plan is to eliminate the presence of NDMA within the hydrazine storage and blending facility and secondly to eliminate the potential exposure of workers to hydrazine and UDMH during any hydrazine operation. To accomplish this objective, a phased approach will be employed to minimize emissions. The plan consists of the following four phases:

1) PHASE I - FACILITY CLEAN-UP AND DECONTAMINATION.
The objective of this phase is to eliminate the presence of ambient NDMA within the facility by controlling the potential sources of NDMA. This will involve such tasks as draining, cleaning, and decontaminating of the waste water open sump and drain lines, and pressure testing (Nitrogen) and repair of the fuel piping. After this work has been completed, an industrial hygiene sampling study will be conducted by Army Environmental Hygiene Agency (AEHA) to certify that the work area is free of NDMA. Personnel will then be able to enter the hydrazine facility without the use of SCBA protection.

2) PHASE II - FACILITY MODIFICATION - NDMA SOURCES.
The primary objective of this phase is to modify process equipment that currently is a potential source of NDMA during fuel transfer operations. This will involve such tasks as: the disconnection of the vent scrubber in the blending station and scrubber piping modifications (vent and waste water) to permit the use of the scrubber in the east storage tank area; modification of the collection and storage of the hydrazine waste water system to provide a closed system and eliminate the use of the open sump; and relocation of the nitrogen supply tanks outside the regulated area. After completion of the above tasks, it is expected that fuel transfer and blending operations could be conducted without contamination of the facility by NDMA.

3) PHASE III - FUEL SYSTEMS MODIFICATIONS. The objective of this phase is to modify the fuel storage tanks to eliminate the exposure of workers to hydrazine and UDMH during inventory and sampling operations. This will involve the installation of electronic liquid level sensors with remote indicators and a closed sampling system. The installation of the above equipment will be accomplished on one tank at a time and will require the transfer of fuel between tanks. As stated above, it is not expected that transfer operations will result in the presence of NDMA. During this period, any USAF priority orders involving the bulk transfer and/or blending of fuel would be accommodated.

4) PHASE IV - DRUM FILLING AND CLEANING AND MISCELLANEOUS.

The objective of this phase is to change the drum filling system and the drum cleaning operation to minimize the exposure of workers to hydrazine and UDMH during these operations. This will involve the installation of special equipment that will maintain a closed system during operations. Another task in this phase is the installation of a life support system (air supply) that would include an air supply source outside the regulated area with distribution lines to various stations within the facility. This system would be utilized by operations and maintenance workers during repair and emergency situations as required. During this phase the vent scrubber in the east storage tank area will be evaluated and if required, a new scrubber will be installed. During this phase the temporary personnel support facility installed under Phase I, may be replaced by more permanent facility.

4. PROTECTIVE MEASURES DURING ABATEMENT PERIOD. Appendix D provides specific procedures pertaining to protective clothing to be used during the abatement period. the procedures outlined should be adequate to address all OSHA concerns, and will lead to full compliance with 29 CFR 1910.1016. There are, however, two areas where it does not appear practicable or necessary to implement the very conservative measures required by the regulation. The areas are: (1) the use of full bodied impervious protective clothing for all entries into the hydrazine facility when NDMA is present; (2) the decontamination of all equipment and vehicles leaving the regulated area when NDMA (vapor) is present. RMA's position concerning these areas is as follows:

a. Use of Full Body Impervious Protective Clothing.

1) The major area of difference between OSHA interpretation of CFR 1910.1016 and what can or should be enforced occurs in the area of when to use a full body impervious protective garment. In its findings OSHA cited paragraph (c)(5)(i) and stated that a full suit was required for all facility entries. RMA took exception at the time of the finding's presentation and continues to do so for the following reasons:

a) Paragraph (c)(5)(i) deals with clean-up of leaks or spills, maintenance or repair operations on contaminated systems/equipment where direct contact with NDMA could result. In our plant this situation may well result from certain types of operations, however, OSHA's interpretation has been that airborne concentrations of NDMA constitute

continuous direct contact and that a full body impervious suit is therefore required for all entries irrespective of type of activity to be performed.

b) The assertion that percutaneous exposure from the very low levels of ambient NDMA constitutes a health hazard is most unlikely from a medical standpoint.

c) The use of M-3 Toxicological Agent Protective Suit can present an acute health and safety hazard due to heat or cold stress. Ref: DARCOM-R-385-102, Chapter 4-1 c.(7) "Maximum wearing time vs Ambient Temp." indicates that wearing time under extreme hot (such as above 90°F) weather is severely limited (15 minutes) and can actually be less than the donning, walk-in, walk-out and undressing time.

d) RMA is currently unequipped to handle or service air cooled suits.

e) Use of full suit protection would make activities necessary to eliminate the current NDMA emissions practically impossible and very hazardous since the use of heavy construction equipment is required during portions of the abatement effort.

2) We believe that a phased approach which ties levels of protective clothing to specific types of activities on the basis of exposure to known or possible NDMA sources is an acceptable approach which will allow the abatement plan to be accomplished with minimum risk of injury to our personnel. This phased approach is presented in Appendix D.

b. Decontamination of Equipment and Vehicles.

1) The major area of difference between the OSHA interpretation and the RMA position is the OSHA requirement (paragraph (d)(4)(iii)) to establish and implement decontamination procedures to remove (suspect) NDMA from surfaces of materials and equipment before leaving the regulated area even when the equipment has only been subjected to extremely low airborne concentrations of NDMA. RMA and the USAF voiced exception to this requirement when OSHA presented its finding's/recommendations and still do for the following reasons:

a) At the very low concentration levels of NDMA found in the hydrazine facility (see Appendix A), calculations indicate that NDMA will not condense out of the atmosphere

at ambient conditions, and so will not contaminate materials and equipment, as suggested by OSHA.

b) Wipe samples of materials and equipment within the hydrazine facility that were/are subjected to airborne concentration of NDMA indicated non-detectable NDMA and UDMH. These results substantiate the theoretical assessment in the above paragraph.

2) RMA recognizes the fact that equipment could become contaminated by direct contact with liquid fuels and/or waste water containing NDMA or UDMH. Decontamination procedures will be established and implemented for use when known or potential contamination of materials/equipment with liquids containing NDMA or hydrazines has occurred.

5. MONITORING PLAN - RMA proposes to implement the following monitoring plan consistent with the plant decontamination, engineering controls, modifications and operations.

a. Phase I - Environmental Monitoring after Facility Clean-up and Decontamination. Upon completion of tasks outlined in Appendix C - Phase I - Facility Clean-up & Decontamination, an industrial hygiene air sampling study will be conducted by AEHA to certify that NDMA is no longer present in the hydrazine facility.

b. Phase II - Environmental and Personnel Monitoring after Engineering Modifications. Appendix C, Phase II - Facility Modifications - NDMA Sources delineates the tasks to be accomplished to eliminate NDMA sources. After completion of Phase II, during Phase III which will involve limited fuel transfer operations, a second industrial hygiene study will be conducted by AEHA to determine the presence of hydrazines and NDMA both during and after fuel transfer operations.

c. Phase III - Environmental Monitoring During Operations. An environmental monitoring system will be installed capable of monitoring hydrazines at multiple sample locations. Monitoring will be performed prior to entry to the facility and during all operations. RMA will have an in-house capability to support this monitoring program to include laboratory chemical analysis. During operations, NDMA will not be monitored, as it is expected Phase II monitoring test results will substantiate that after facility modifications have been completed eliminating NDMA sources, monitoring only for hydrazines will be required. (i.e. if hydrazines are not present than NDMA cannot be present.)

6. MEDICAL SURVEILLANCE PROGRAM DURING ABATEMENT PERIOD.

During the period of clean-up (Phase I), while the possibility of contamination by and exposure of NDMA exists, special medical surveillance of the workers will be in effect. This will consist of approximately weekly contact with medical personnel, who will check for any evidence of illness, document the medical record, and get monthly urinalysis and liver function studies, and perform any other medical investigation studies that may be indicated.

7. RESPONSES TO OSHA FINDINGS. Appendix E indicates specific actions to be taken that will eliminate any health hazard posed by presence of NDMA in the hydrazine facility and also addresses the OSHA findings.

APPENDIX A
SAMPLING RESULTS AT ROCKY MOUNTAIN ARSENAL

DATE	SAMPLE ID	TYPE	OPERATION	LOCATION OF SAMPLER	LEGTH OF SAMPLER(MIN)	CONTAMINANT	PLU'S		TUA
							Hydrazine UDHII NUMA	EXPOSURE	
01/28/82	RHA 1 & 3	Area	Transfer from Storage Tank to Truck Tanker	In Office	50	Dimethyl Amine	N.D.	N.D.	---
	RHA 2 & 4	Area		Sump (North side)	50	"	N.D.	N.D.	---
	RHA 8	Personal		Pete Hollendor	200	Hydrazine UDHII	N.D. .06mg/m ³	N.D. .06mg/m ³	.017mg/m ³
	RHA 14	Personal		" "	73	Hydrazine UDHII	N.D.	N.D.	---
	RHA 9	Personal		Rudy Martinez	200	Hydrazine UDHII	N.D.	N.D.	---
	RHA 15	Personal		" "	48	Hydrazine UDHII	N.D.	N.D.	---
	RHA 10	Personal		Abe Padilla	210	Hydrazine UDHII	N.D.	N.D.	---
	RHA 16	Personal		" "	71	Hydrazine UDHII	N.D.	N.D.	---
	RHA 11	Area		Office	200	Hydrazine UDHII	N.D.	N.D.	---
	RHA 17	Area		" "	51	Hydrazine UDHII	N.D.	N.D.	---
	RHA 12	Area		Sump (north side)	200	Hydrazine UDHII	N.D.	N.D.	---
	RHA 18	Area		" "	43	Hydrazine UDHII	N.D.	N.D.	---
	RHA 13	Area		Support Beam Near Office	200	Hydrazine UDHII	N.D.	N.D.	---
	RHA 19	Area		" "	41	Hydrazine UDHII	N.D.	N.D.	---
	RHA 20	Personal		Pete Hollendor	273	NUMA	39.0ug/m ³	39.0ug/m ³	22.2ug/m ³
	RHA 21	Personal		Rudy Martinez	267	NUMA	9.6ug/m ³	9.6ug/m ³	5.3ug/m ³
	RHA 22	Personal		Abe Padilla	279	NUMA	16.0ug/m ³	16.0ug/m ³	9.3ug/m ³
	RHA 23	Area		Office	252	NUMA	10.0ug/m ³	10.0ug/m ³	5.25ug/m ³
	RHA 24	Area		Sump (north side)	242	NUMA	4.1ug/m ³	4.1ug/m ³	2.1ug/m ³
	RHA 25	Area		Support Beam Near Office	240	NUMA	1.5ug/m ³	1.5ug/m ³	.75ug/m ³

APPENDIX A
SAMPLING RESULTS AT ROCKY MOUNTAIN ARSENAL

DATE	SAMPLE ID	TYPE	OPERATION	LOCATION OF SAMPLER	LENGTH OF SAMPLER (IN)	CONTAMINANT	EXPOSURE	1/A
02/16/82	RHA 30	Personal	Inventory	Pete Mollendor	63	NDHA	61.0ug/m ³	8.0ug/m ³
	RHA 32	Personal		Abe Padilla	55	NDHA	15.0ug/m ³	1.7ug/m ³
	RHA 31	Personal		Pete Mollendor	63	Hydrazine UDHH	0.42mg/m ³ 9.8 mg/m ³	0.55mg/m ³ 1.3mg/m ³
	RHA 33	Personal		Abe Padilla	55	Hydrazine UDHH	0.9mg/m ³ 36.1mg/m ³	1.03mg/m ³ 4.14ug/m ³
02/25/82	RHA 40	Area	Background Levels	N.W. Corner Tank Farm	276	NDHA	0.58ug/m ³	0.33ug/m ³
	RHA 41	Area		Office	274	NDHA	2.7ug/m ³	1.54ug/m ³
	RHA 42	Area		Sump (N.E. corner)	274	NDHA	2.7ug/m ³	1.54ug/m ³
	RHA 43	Area		Sump (S.W. corner)	274	NDHA	1.8ug/m ³	1.03ug/m ³
	RHA 44	Area		North Out Building	270	NDHA	< 0.37ug/m ³	---
	RHA 45	Area		Truck Loading Bay	269	NDHA	2.6ug/m ³	1.46ug/m ³
	RHA 46	Area		Rail Car Loading Bay	268	NDHA	1.5ug/m ³	0.84ug/m ³
	RHA 47	Area		Control Station	267	NDHA	2.6ug/m ³	1.45ug/m ³
	RHA 48	Area		Drum Storage	266	NDHA	0.43ug/m ³	0.24ug/m ³
	RHA 49	Area		Tank Farm Between HAS & CS 1	265	NDHA	2.3 ug/m ³	1.3ug/m ³
	RHA 50	Area		S.E. Corner Tank Farm	263	NDHA	1.0ug/m ³	0.55ug/m ³
	RHA 51	Area		Outer Gate (North)	262	NDHA	< 0.38ug/m ³	---
	RHA 55	Area		North Side Building 111	252	NDHA	N.D.	---
	RHA 56	Area		N.E. side Basin "F"	198	NDHA	N.D.	---
03/10/82	RHA 58	Area	Background Levels at other parts of the Arsenal	South side Building 831	193	NDHA	N.D.	---
	RHA 60	Area		E. side Building 1710 (Clinic)	191	NDHA	N.D.	---
	RHA 62	Area		S. of Building 538	172	NDHA	N.D.	---
	RHA 64	Area		Building 314 in Lunch Room	171	NDHA	N.D.	---
	RHA 57	Area		N.E. side Basin "F"	191	Hydrazine UDHH	N.D.	---

APPENDIX A
SAMPLING RESULTS AT ROCKY MOUNTAIN ARSENAL

DATE	SAMPLE ID	TYPE	OPERATION	LOCATION OF SAMPLER	LEGTH OF SAMPLER(MIN)	CONTAMINANT	EXPOSURE	TWA
01/10/82	RMA 59	Area	Background Levels at other Parts of Arsenal	South side Building 831	193	Hydrazine UDMH	N.D. N.D.	
	RMA 61	Area		E. side Building 1710 (Clinic)	190	Hydrazine UDMH	N.D. N.D.	
	RMA 63	Area		South of Building 538	172	Hydrazine UDMH	N.D. N.D.	
	RMA 65			Building 314 in Lunchroom	170	Hydrazine UDMH	N.D. N.D.	
	RMA 69	Area	Draining Sump	On retaining wall of storage tank east of hydrazine facility	60	NDHA	N.D.	
	RMA 70	Personal		Rudy Martinez	224	NDHA	< .45ug/m ³	
	RMA 72	Personal		Abe Padilla	220	NDHA	0.64ug/m ³	0.24ug/m ³
	RMA 68	Area		On retaining wall of Storage Tank east of hydrazine facility	60	Hydrazine UDMH	N.D. N.D.	
	RMA 71	Personal		Rudy Martinez	185	Hydrazine UDMH	N.D. N.D.	
	RMA 73	Personal		Abe Padilla	183	Hydrazine UDMH	N.D. N.D.	
03/17/82	RMA 83	Personal	Transfer UDMH from rail car to storage tank.	Abe Padilla	193	Hydrazine UDMH	N.D. N.D.	
	RMA 84	Personal		" "	145	Hydrazine UDMH	N.D. N.D.	
	RMA 85	Personal		" "	338	NDHA	1.9ug/m ³	1.34ug/m ³
	RMA 86	Personal		Rudy Martinez	194	Hydrazine UDMH	N.D. N.D.	
	RMA 87	Personal		Rudy Martinez	144	Hydrazine UDMH	N.D. N.D.	
	RMA 88	Personal		Rudy Martinez	338	NDHA	1.4ug/m ³	1.00ug/m ³
	RMA 89	Personal		Harvey Lynch	199	Hydrazine UDMH	N.D. N.D.	
	RMA 90	Personal		" "	137	Hydrazine UDMH	N.D. N.D.	

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SAMPLING RESULTS AT ROCKY MOUNTAIN ARSENAL

DATE	SAMPLE ID	TYPE	OPERATION	LOCATION OF SAMPLER	LEGTH OF SAMPLER (IN)	CONTAMINANT	EXPOSURE	TWA
03/17/82	RMA 91	Personal	Transfer UDMH from rail car to storage tank.	Harvey Lynch	336	NDMA	1.5ug/m ³	1.05ug/m ³
	RMA 93	Area		Near Scrubber Vent	183	Hydrazine UDMH	N.D.	
	RMA 94	Area		" " "	120	Hydrazine UDMH	N.D.	
	RMA 95	Area		" " "	186	NDMA	1.3ug/m ³	1.81ug/m ³
	RMA 96	Area		" " "	118	NDMA	5.3ug/m ³	
	RMA 98	Area		In Office	235	Hydrazine UDMH	N.D.	
	RMA 99	Area		In Office	66	Hydrazine UDMH	N.D.	
	RMA 100	Area		" " "	303	NDMA	N.D.	
	RMA 102	Area		At Control Panel	230	Hydrazine UDMH	1.1ug/m ³	.69ug/m ³
	RMA 103	Area		" " "	67	Hydrazine UDMH	16.0ug/m ³	9.9ug/m ³
	RMA 104	Area		" " "	298	NDMA	56.0ug/m ³	43.01ug/m ³
	RMA 78	Area	Draining Sump	In Office near Drain	240	NDMA	116.0ug/m ³	18.63ug/m ³
	RMA 79	Area		North Out Building on Refrigerator	240	NDMA	30.0ug/m ³	
	RMA 81	Bulk		Sump Water		NDMA	3.5ug/m ³	1.25ug/m ³
	RMA 82	Bulk		Sump Water		Hydrazine UDMH	< .42ug/m ³	
01/17/82	RMA 92	Area	Transfer of rail car of UDMH	Scrubber Near Vent Pipe (Bubbler)	300	NDMA	1.8ug/m ³	1.13ug/m ³
	RMA 97	Area		Office (Bubbler)	298	NDMA	.27ug/m ³	.17ug/m ³
	RMA 101	Area		Control Panel (Bubbler)	294	NDMA	16.9ug/m ³	10.35ug/m ³
	RMA 105	Area		Tank Farm, east side of US 1	293	NDMA	.16ug/m ³	.095ug/m ³
	RMA 106	Area		On Top Tank CS 1	228	Hydrazine UDMH	N.D.	
							N.D.	

APPENDIX A
SAMPLING RESULTS AT ROCKY MOUNTAIN ARSENAL

DATE	SAMPLE ID	TYPE	OPERATION	LOCATION OF SAMPLER	LENGTH OF SAMPLER (MIN)	CONTAMINANT	EXPOSURE	TVA
07/17/82	RMA 107	Area	Transfer UDMH from rail car to storage tank	On top tank CS 1	66	Hydrazine UDMH	H.D. N.D.	---
	RMA 108	Area		" " " "	294	NDMA	H.D.	---
	RMA 112	Wipe		Abe Padilla's Apron	N/A	NDMA Hydrazine UDMH	N.D. H.D. H.D.	---
	RMA 113	Wipe		Rudy Martinez' Apron	N/A	NDMA Hydrazine UDMH	H.D. ≤ 700/m ³	---
	RMA 114	Wipe		Dip sticks used to guage tanks	N/A	NDMA Hydrazine UDMH	H.D. H.D. H.D.	---
	RMA 115	Wipe		Desk in Office	N/A	NDMA Hydrazine UDMH	H.D. N.D. H.D.	---

APPENDIX B
OSHA INSPECTION FINDINGS

1
29 CFR 1910.134(b)(6): Respirators were not stored in a convenient, clean and sanitary location:

(a) In the hydrazine facility, self-contained breathing apparatus used for routine operations were stored in the office which was contaminated with N-nitrosodimethylamine.

2a
29 CFR 1910.1000(a)(2): Employee(s) were exposed to material(s) in excess of the 8-hour time weighted average limit(s) listed for the particular material(s) in Table Z-1 of subpart Z of 29 CFR part 1910:

(a) In the hydrazine facility, the two chemical plant operators engaged in an inventory operation of the above ground storage tanks were exposed to levels of 1,1 dimethylhydrazine in excess of those listed in Table Z-1 as follows:

Operator #1 - 1.3 mg/m³, 1.3 times the standard.

Operator #2 - 4.14 mg/m³, 4.14 times the standard.

2b
29 CFR 1910.1000(e): Feasible administrative or engineering controls were not determined and implemented to reduce employee exposure(s):

(a) In the hydrazine facility, the two chemical plant operators were overexposed to 1,1 dimethylhydrazine and feasible engineering controls were not implemented.
See exposures in Item 2a, above.

The following items, 3 through 21, are work practice controls required when exposed to NDMA. The recommended exposure limit is the detection limit, 0.01 ug per sample. The results of sampling at Rocky Mountain Arsenal showed personal exposures ranging from about 1.4 ug/m³ to 61 ug/m³, which is 140 to 6100 times the detection limit.

3
29 CFR 1910.1016(c)(2)(ii): Employees were not required to wash hands, forearms, face, and neck upon each exit from the regulated area, close to the point of exit and before engaging in other activities:

(a) In the hydrazine facility, employees were not required to wash near the point of exit of the regulated area upon each exit.

4
29 CFR 1910.1016(c)(3): Open vessel system operations as defined in paragraph (b)(13) were not prohibited:

(a) In the hydrazine facility, the waste water sump, an open vessel operation, was not prohibited.

5
29 CFR 1910.1016(c)(4)(iii): Employees were not provided with clean, full body protective clothing, shoe covers, and gloves prior to entering the regulated area:

(a) In the hydrazine facility, employees were not provided with shoe covers and gloves prior to entering the regulated area.

6
29 CFR 1910.1016(c)(4)(v): Prior to each exit from a regulated area, employees were not required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal:

(a) In the hydrazine facility, employees did not remove and leave protective coveralls at the point of exit, and also, at the last exit of the day the coveralls were not placed in impervious containers at the point of exit for decontamination or disposal.

7
29 CFR 1910.1016(c)(4)(viii): Drinking fountains were not prohibited in the regulated area:

(a) On the West side of the hydrazine facility in the North out-building, a drinking fountain was in operation.

20 CFR 1010.1016(c)(5)(i): In clean-up of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with N-Nitrosodimethylamine could result, each authorized employee entering that area was not provided with and required to wear clean, impervious garments, including gloves, boots and continuous-air supplied hood in accordance with 1010.134:

(a) In the hydrazine facility, employees engaged in routine maintenance were not required to wear impervious garments and continuous air supplied hood. At times these employees wore M-9 gas masks or no respiratory protection at all. Also, the protective clothing at times was a pair of coveralls.

29 CFR 1010.1016(c)(5)(ii): In clean-up of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with N-Nitrosodimethylamine could result, each authorized employee entering that area was not decontaminated before removing the protective garments and hood:

(a) In the hydrazine facility, employees engaged in routine maintenance operations were not decontaminated before removing protective garments.

10
20 CFR 1010.1016(c)(5)(iii): In clean-up of leaks or spills, maintenance or repair operations on contaminated systems or equipment, where direct contact with N-Nitrosodimethylamine could result, each authorized employee entering that area was not required to shower upon removing the protective garments and hood:

(a) In the hydrazine facility, employees engaged in routine maintenance operations were not required to shower upon removing the protective garments.

11
29 CFR 1010.1016(d)(2)(i): In an emergency, immediate measures including, but not limited to, the requirements of subdivisions (i), (ii), (iii), (iv), and (v) of this paragraph were not implemented:

(i) The potentially affected area was not evacuated as soon as the emergency had been determined.

(ii) Hazardous conditions created by the emergency were not eliminated and the potentially affected area was not decontaminated prior to resumption of normal operations.

(iii) Special medical surveillance by a physician was not instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.

(iv) Where an employee has a known contact with N-Nitrosodimethylamine, such employee was not required to shower as soon as possible, unless contraindicated by physical injuries.

(v) An incident report on the emergency was not reported as provided in paragraph (f)(2) of this section.

(a) In the hydrazine facility, emergency procedures had not been established and implemented.

NOTE: Based on the definition of "emergency" in 1910.1016(b)(8) i.e., "circumstance or set of circumstances resulting in the release of N-Nitrosodimethylamine which may result in exposure to or contact with N-Nitrosodimethylamine", the normal operation of this hydrazine facility can be defined as an emergency situation because HDMA is constantly present.

12

29 CFR 1910.1016(d)(3)(i): Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products, were not prohibited in the regulated area:

(a) On the West side of the hydrazine facility, in the north out-building several cases of Gatorade were being stored.

13

29 CFR 1910.1016(d)(3)(ii): Where employees are required by this section to wash, washing facilities were not provided in accordance with 1910.141(d)(1) and (2)(ii) through (vii):

(a) In the hydrazine facility, washing facilities were not provided.

14

29 CFR 1910.1016(d)(3)(iii): Where employees are required by this section to shower, shower facilities were not provided in accordance with 1910.141(d)(3):

(a) In the hydrazine facility, shower facilities were not provided.

15

29 CFR 1910.1016(d)(3)(iv): Where employees wear protective clothing and equipment clean change rooms were not provided, in accordance with 1910.151(e), for the number of such employees required to change clothes:

(a) In the hydrazine facility, clean change rooms were not provided.

16

29 CFR 1910.1016(d)(4)(ii): Any equipment, material, or other item taken into or removed from a regulated area was not done so in a manner that does not cause contamination in nonregulated areas or the external environment:

(a) In the hydrazine facility, motor vehicles and SCBA tanks were removed from the regulated area without being decontaminated.

17

29 CFR 1910.1016(d)(4)(iii): Decontamination procedures were not established and implemented to remove N-Nitrosodimethylamine from the surfaces of materials, equipment, and the decontamination facility:

(a) In the hydrazine facility, decontamination procedures had not been established or implemented.

18

29 CFR 1910.1016(e)(1)(ii): Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section were not posted with signs bearing the legend:

CANCER SUSPECT AGENT
EXPOSED IN THIS AREA
IMPERVIOUS SUIT INCLUDING
GLOVES, BOOTS, AND AIR-
SUPPLIED HOOD REQUIRED
AT ALL TIMES
AUTHORIZED PERSONNEL ONLY

(a) In the hydrazine facility, the above noted warning

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29 CFR 1910.1016(e)(1)(iii): Appropriate signs and instructions were not posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area:

- (a) In the hydrazine facility, signs and instructions were not posted.

20

29 CFR 1910.1016(e)(5)(i): Each employee prior to being authorized to enter a regulated area, did not receive a training and indoctrination program including, but not necessarily limited to:

- (a) The nature of the carcinogenic hazards of N-Nitrosodimethylamine, including local and systemic toxicity;
- (b) The specific nature of the operation involving N-Nitrosodimethylamine which could result in exposure;
- (c) The purpose for the application of the medical surveillance program, including as appropriate, methods of self-examination;
- (d) The purpose for and application of decontamination practices and purposes;
- (e) The purpose for and significance of emergency practices and procedures;
- (f) The employee's specific role in emergency procedures;
- (g) Specific information to aid the employee in recognition and evaluation of conditions and situations which may result in the release of N-Nitrosodimethylamine;
- (h) The purpose for and application of specific first aid procedures and practices.

- (1) In the hydrazine facility, a training and indoctrination program had not been established and implemented.

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29 CFR 1910.1016(e)(5)(ii): Specific emergency procedures were not prescribed and posted:

- (a) In the hydrazine facility, emergency procedures had not been established.

APPENDIX C
HAZARD ABATEMENT PLAN

1. Phase I - Facility Clean-up and Decontamination.

<u>TASK</u>	<u>DESCRIPTION/COMMENT</u>
a. Drain Sump.	Waste water containing NDMA in open sump within facility will be pumped to storage tanks in east area. Pump controls are remote operated.
b. Install personnel support facility.	Special modified trailer designed for use as personnel change facility in support of lethal chemical agent operations will be installed at hydrazine facility.
c. Provide Protective Equipment.	Procure air supplied respirators with umbilical adapter and set up mobile air supply system within facility.
d. Decontaminate Sump/Drains.	Sump and drain lines will be cleaned and decontaminated. Waste will be pumped to east storage tanks.
e. Fuel System Test.	Pressure testing (Nitrogen) of fuel piping will be conducted. Minor repairs will be done.
f. Industrial Hygiene Sampling.	An industrial hygiene air sampling study will be conducted by AEHA to certify that NDMA is no longer present in the hydrazine facility. Survey will also include sampling for the presence of hydrazine and UDMH.

2. Phase II - Facility Modification - NDMA Sources.

a. Modify Scrubber System	Present vent scrubber is located within blender control area and waste water containing NDMA flows (openly) into drain line. This scrubber will be disconnected from hydrazine vent piping, thus eliminating source of NDMA within that part of the facility. The scrubber located in the east storage tank area will be connected to the vent system and the waste
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TASKDESCRIPTION/COMMENT

water will be collected and pumped to the east storage tanks.

- b. Modify Waste Water System.

The existing waste water system is an open system. Modifications would include the elimination of the sump, modification of the drains, and a new underground waste water pipe to the east storage tanks.

- c. Relocate Nitrogen Supply.

Existing nitrogen supply is within regulated area. This task is to relocate supply tanks outside regulated area.

3. Phase III -- Fuel System Modifications.

- a. Install Liquid Level System.

This task involves the placement of electronic liquid level sensors within each of six bulk storage tanks and the installation of electrical wiring/controls to a remote indicator panel within Bldg 759.

- b. Modify Fuel Sampling System.

Present method of fuel sampling is open system. Task involves the installation of closed sampling devices at various locations in the fuel piping system.

- c. Fuel System Leak Test.

The installation of a liquid level sensors require the storage tank to be empty of fuels. During fuel transfer operation to accommodate this task, the fuel lines will be checked using a hydrazine/UDMH leak detector.

- d. Industrial Hygiene Sampling Study.

A second industrial hygiene sampling study will be conducted by AEHA, to certify that NDMA is not present within the work area after fuel transfer operations have been performed.

4. Phase IV - Drum Filling and Cleaning and Misc.

<u>TASK</u>	<u>DESCRIPTION/COMMENT</u>
a. Drum Filling Modifications.	The existing drum filling station allows fuel leaks to occur during making and breaking of connections. This modification would eliminate this hazard by providing an enclosed system.
b. Install Drum Cleaning Equipment.	The existing system of cleaning drums allows fuel vapors to escape when connecting cleaning lines to the drum. The installation of new enclosed drum cleaning equipment would eliminate this hazard.
c. Install Life Support System.	This task would involve the installation of a air supply system located outside the regulated area with distribution lines to multiple fixed stations within the facility, thus permitting personnel to work for extended periods using SCBA.
d. Install new Scrubber East Area.	During Phase I ^{II} , the existing scrubber located in the east storage tank area will be connected to the fuel vent system. Engineering tests will be conducted, with results to determine whether a new scrubber will be required.
e. Construct Personnel Support Facility.	Approval for construction of permanent personnel support facility is dependent on long term requirement for continued use of hydrazine facility which is presently under study by USAF.

APPENDIX D

1. General. This appendix deals with the following areas of concern:

- a) Types of Operations.
- b) Protective Clothing to be used during the abatement period.
- c) Dress and undress procedures for each level of protection.

All areas of concern will be incorporated into the appropriated standing operating procedure prior to implementation.

2. Types of Operations. For purposes of clarifying the occasion for use of various levels of Protective Clothing the types of operations which will be performed during the abatement period can be classified into four types:

- Type 1: Routine entry for inspection, data gathering and other administrative purposes which require no contact with liquids containing NDMA or operation of equipment.
- Type 2: Entry to conduct abatement or routine operations on equipment where the possibility of exposure to NDMA bearing liquid or UDMH has been practically eliminated.
- Type 3: Conduct of abatement or routine operations where the possibility of exposure to NDMA bearing liquid or UDMH exists only under unforeseen circumstances.
- Type 4: Conduct of abatement or routine maintenance and repair, conduct of decontamination operations, where exposure to NDMA bearing liquid or UDMH is probable or certain.

3. Protective Clothing.

a. Definition of Levels: The protective clothing to be employed consists of four levels which roughly correspond to those levels used for lethal chemical agent operations. The primary difference being the type of respiratory protection required. The following comprise the definitions and content of the various protective clothing levels:

1) Level A (Modified):

Inner Clothing:

- a) Undershirt, unimpregnated
- b) Drawers, unimpregnated
- c) Socks, unimpregnated

Liner: Coveralls, disposable, tyvek material.

Outer Clothing: Suit - Coverall, Toxicological Agent Protective (TAP) M3.

Gloves: Butyl (TAP) M4

Footwear: Boots, butyl, safety toe, TAP, M2A1

Headgear: Hood, butyl rubber, MSA (for SCBA)

Respirator: SCBA, Mine Safety Appliances or Scott

2) Level B (Modified):

Inner Clothing:

- a) Drawers, unimpregnated
- b) Undershirt, unimpregnated
- c) Socks, unimpregnated

Outer Clothing: Apron, TAP, M2

Gloves: Butyl, TAP, M4

Footwear: Boots, butyl, safety toe, TAP, M2A1

Headgear: Hood, butyl rubber, MSA (for SCBA)

Respirator: SCBA, Mine Safety Appliances or Scott

3) Level D (Modified):

Inner Clothing:

- a) Drawers, unimpregnated
- b) Undershirt, unimpregnated
- c) Socks, unimpregnated

Outer Clothing: Coveralls, disposable, tyvek material

Gloves: Surgical, disposable

Footwear: Boots, butyl, steel toed, TAP, M2A1

Headgear: None

Respirator: SCBA, MSA or Scott

4) Level D (Standard):

Inner Clothing:

- a) Drawers, unimpregnated
- b) Undershirt, unimpregnated
- c) Socks, unimpregnated

Outer Clothing: Coveralls, explosive handlers, cotton

Gloves: None

Footwear: Shoes, safety toe

Headgear: None

Respirator: M9 protective mask, slung

b. Protective Clothing requirements by Phase and Type of Operation. The following represent the levels of protective clothing to be employed during the four phases of the abatement period, correlated to the type of operation expected to occur.

Phase I - Facility Clean-up and Decontamination.

Examples of
Types of Operation

Protective Clothing Level

Type 1: Routine Safety Inspection, data collection on nitrogen tank and sump pit levels; check of sprinkler system and heat trace system; non-product equipment maintenance.

Modified Level D

Type 2: Draining of Sump via remote pump controls, etc.

Modified Level D

<u>Examples of Types of Operation</u>	<u>Protective Clothing Level</u>
Type 3: External equipment wash-down, application of decontaminant to sump if done remotely, etc.	Modified Level B
Type 4: Disassembly of equipment containing UDMH Vapors or wastewater, etc.	Modified Level A

Phase II - Facility Modifications - NDMA Sources

<u>Examples of Types of Operation</u>	<u>Protective Clothing Level</u>
Type 1: Routine Inspections as above, Operation of Construction Equipment or process equipment not containing UDMH or wastewater; non product equipment maintenance.	Standard Level D
Type 2: Installation or Maintenance operations on equipment where NDMA contact has been practically eliminated.	Modified Level D
Type 3: External equipment wash-down, application of decontaminant to sump if done remotely, etc.	Modified Level B
Type 4: Disassembly of equipment containing UDMH vapors or wastewater, etc.	Modified Level A

Phase III - Storage Tank Modifications and Limited Bulk Operations.

<u>Examples of Types of Operation</u>	<u>Protective Clothing Level</u>
Type 1: As in Phase I, after re-initiation of Bulk operations but prior to certification by monitoring of NDMA absence.	Modified Level D
Type 2: As above, also certain maintenance activities on non-product equipment	Modified Level D

Examples of
Types of Operations

Protective Clothing Level

Type 3: Operation of Fuels Process
Equipment to accomplish
blending, transfer, etc;
Certain aspects of Product
Equipment Maintenance

Modified Level B

Type 4: Maintenance requiring
opening UDMH product lines
or contaminated wastewater
lines.

Modified Level A

Phase IV - Modification for Drum Type Operations

Examples of
Types of Operations

Protective Clothing Level

Type 1: As in Phase III above
unless facility has been moni-
tored clean prior to Phase IV
initiation.

Modified Level D
(Level D Standard,
if monitored clean)

Type 2: As above, includes cer-
tain phases of drum equipment
installation.

Modified Level D

Type 3: As above, includes
certain phases of drum equip-
ment or scrubber system in-
stallation.

Modified Level B

Type 4: Installation or Main-
tenance requiring opening of
UDMH Product or contaminated
wastewater lines.

Modified Level A

4. Dress and Undress Procedures.

a. Specific instructions to accommodate provisions of 1016 regulation will be incorporated into Standing Operating Procedures. The procedures for various levels of dress will comply with the following regulatory sections:

Level of Protection

Regulatory Citation
Summary of Requirement

Standard Level D

Para (c)(2)(ii) / Wash Hands,
forearms, face and neck
upon each exit.

Level of Protection

Regulatory Citation
Summary of Requirement

Modified Level D

Para (c)(4)(v)-(vii) /
At point of exit remove and
leave protective clothing,
or last exit place clothing
in containers for decon/
disposal. Wash hands, fore-
arms, face and neck on each
exit: Shower after last
exit of day.

Modified Level B

None / Wash gloves and boots
before removing protective
garments, wash hands, fore-
arms, face and neck on each
exit; shower after last
exit of day.

Modified Level A

Para (c)(5)(ii)-(iii) / Decon-
tamine before removing
protective garments; shower
at each exit.

b. Procedures involving disposal or decontamination
and laundering of protective garments will be incorporated
in the above mentioned SOP's.

APPENDIX E
RESPONSE TO OSHA FINDINGS

1. General. This appendix delineates the specific actions that RMA will take in response to the OSHA findings. These actions will be taken as required to support the phased abatement plan outlined in Appendix C. When implemented, the health risk posed by the NDMA vapors now present in the hydrazine facility will be greatly reduced and future hydrazine operations should be in compliance with 29 CFR 1910.1016. In many cases a single response satisfies more than one OSHA finding and the finding are so grouped.

2. Specific Responses.

a. OSHA findings No. 1, 3, 6, 12, 13, 14 and 15. Prior to decontamination and clean-up work within the hydrazine plant, a personnel support facility will be provided near the entrance to the regulated area. In order to initiate Phase I activities as soon as possible, RMA intends to install a special modified trailer as the personnel support facility. This trailer was designed to meet personnel support requirements for lethal chemical operations which are similar in nature. The personnel support facility will provide a clean and sanitary location for storage of protective equipment and clothing, a clean change area, a wash and shower room, and a clean administrative area. SOP's will be prepared describing the use of this facility; to include such activities as; change out and proper storage of protective and work clothing, wash and shower requirements, and restrictions on smoking, eating and drinking within both the regulated area and support facility.

b. OSHA findings No. 2a and 2b. Phase III - Storage tank modifications will include the installation of liquid level sensors, with remote indicators, on all storage tanks. Physical inventory operations on the storage tanks with the potential to expose workers will no longer be performed.

c. OSHA finding No. 4. As part of Phase I (Facility clean-up and decontamination) activities, the contents of the waste water sump will be pumped to the east storage tanks and the sump cleaned and decontaminated, also the drain lines will be cleaned and decontaminated. Phase II (Facility modifications - NDMA sources) will include the modification of the waste water collection and storage system to effect a closed system. This task will include the elimination of the open sump, modification to the drain lines, and the elimination of the scrubber waste water open discharge to the drain system.

d. OSHA finding No. 5. All protective clothing will be stored in the clean area of the personnel support facility. Appropriate protective clothing as indicated in Appendix D will be provided and worn prior to entering the regulated area.

e. OSHA finding No. 7. The subject drinking fountain will be disconnected.

f. OSHA findings No. 8 and 9. Appendix D addresses protective clothing levels and decontamination requirements for operational and emergency activities. All personnel wearing modified Level A will be decontaminated prior to removing protective garments and entering the personnel support facility.

g. OSHA finding No. 10. Any employee potentially exposed to NDMA containing liquid, liquid containing an NDMA source or entering the regulated area for types of operations covered by para (c)(5) will be required to shower immediately upon removing protective garments.

h. OSHA findings No. 11 and 21. During routine hydrazine operations, an emergent situation will include any situation where NDMA vapors or liquid contaminated with NDMA exposed to the open air, are present within the facility. During these situations, provisions of 29 CFR 1910.1016 (d)(2) will be implemented consistent with the need to reduce the hazard of spontaneous hydrazine ignition. An SOP describing the emergency procedures to be followed will be established and implemented as part of the overall major revision of operational procedures.

i. OSHA findings No. 16 and 17. Equipment and material within the regulated area known to have come in direct contact with NDMA containing liquid or an NDMA liquid source will be considered contaminated and will be decontaminated prior to leaving the regulated area. Decontamination procedures will be established and implemented.

j. OSHA findings No. 18 and 19. Since the hydrazine facility is an open air installation it does not contain discreet operational areas which can be posted with warning signs specific with regard to protective clothing, as required by 29 CFR 1910.1016 para (e)(1)(ii). The level of clothing worn depends on the actions to be performed. If the intent of posting is to remind and warn, the content of the signs must be kept pertinent and non-confusing or else they will be ignored. Therefore, areas known to contain NDMA contaminated liquid will be posted according to (e)(1)(ii) with the

exact requirements to insure that the instructions are specific and non-ambiguous. Areas known to be contaminated with NDMA vapors will be posted similarly except that references to impervious suit will be deleted. The facility already has the appropriate warning signs posted at entry points according to (e)(1)(i). The remaining required instructions, (para (e)(1)(iii)) will be posted as appropriate.

k. OSHA finding No. 20. Each employee working in the hydrazine facility will receive the required training and indoctrination program. A program will be established and implemented to effect this training.

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